# Cuticular lipids of *Liposcelis bostrycophila* and their implications for tolerance of entomopathogenic fungi

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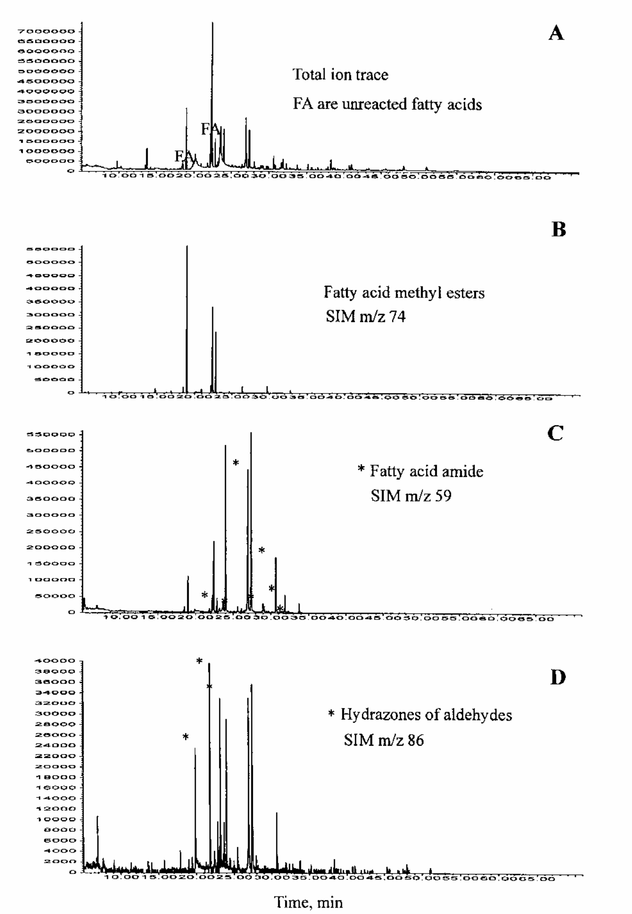


Figure 1. Products and unreacted material from (1,1)-N,N-dimethylhydrazine reaction of cuticular extract of *Liposcelis bostrychophila*.

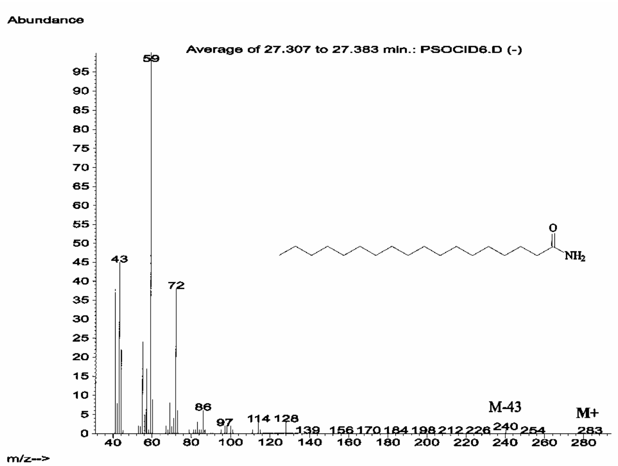


Figure 2. EI-MS of stearoylamide isolated from the cuticle of *Liposcelis bostrychophila*.

*Liposcelis bostrycophila* is psocopteran whose presence in dwellings and stored foods is drawing increasing concern in many areas of the world because of its enormous population growth potential. In an effort to find nontoxic agents for its control, we conducted maximum challenge assays of fungi of broad host range. The results demonstrate that it is remarkably tolerant of the best known entomopathogenic Hyphomycetes (Table 1). We suspected that cuticular lipids might play a role in this tolerance. We characterized cuticular lipid extracts with electron impact mass spectral analysis and measured the effect of selected polar components on adherence, germination and growth of *Beauveria bassiana* and *Metarhizium anisopliae*.

## Cuticular lipids

No unsaturated hydrocarbons were present. A homologous series of n-alkanes ($C_{21}$ to $C_{34}$), monomethyl alkanes (3-, 4-, 5-, 7-, 9-, 11-, 12-, 13- and 15-methyl-) with a carbon chain range of $C_{28}$ to $C_{42}$, and dimethyl alkanes (3, 7-; 9, 13-; 11, 15-; 13, 17-; 9, 21-; 11, 19-; and 13, 21-) with a carbon number range of $C_{31}$ to $C_{43}$ were identified. Hydrocarbons comprised 0.0125 percent of total biomass. Free fatty acids ($C_{16:1}$, $C_{16:0}$, $C_{18:2}$, $C_{18:1}$ and $C_{18:0}$ in chain length) and three straight chain aldehydes ($C_{15}$, $C_{16}$ and $C_{17:1}$ in chain length) were also detected. There were fatty amides in a homologous series ($C_{16}$ to $C_{22}$ in chain length)(Figure1), with the major amide being stearoylamide (Figure 2). **Fatty amides, which were relatively abundant, have not previously been reported among insect cuticular lipids.**

## Lipid-fungus interactions

*Germination.* Conidia were suspended in 0.25% glucose and spread on water agar with 20mM lipid. None of the tested compounds that were found on psocids inhibited germination. Only fatty acids of 12 or less carbons were inhibitory, and stearoylamide mitigated the inhibition. Cis-9-hexadecenal had no effect. (Figure 3)

*Growth.* Two short-chain fatty acids, not found on *L. bostrycophila* inhibited growth. Caprylic acid prevented mycelial growth on 25% Sabouraud dextrose agar. Lauric acid significantly inhibited growth of *M. anisopliae* but not *B. bassiana* ($P$<0.01). Palmitic acid and stearoylamide had no significant effect. (Figure 4).

*Adherence.* Adherence of dry conidia of both fungi to stearoylamide-coated surfaces did not differ significantly from adherence to *L. bostrycophila* or paraffin. Adherence of both fungi was greatest with polystyrene ($P$<0.01 (Figure 5). This suggests that hydrophobic interaction is a factor, but not the sole factor involved in adherence. Adherence to a *B. bassiana*-susceptible beetle, *Oryzaephilus surinamensis*, was significantly reduced by pretreatment with stearoylamide.

**We propose that a function for cuticular fatty amides on *L. bostrychohila* may be to minimize the effect of fungal assault by obstructing the adherence of conidia. No antifungal activity for *L. bostrychohila* cuticular fatty acids and aldehydes was detected.**

Table 1. Mortality of *Lipocelis bostrychophilus* after 10 days of maximum-challenge exposure to conidia of four fungus species.

| Fungus | mortality ±SE |
|---|---|
| *Metarhizium anisopliae* | 11.3 ±4.2a |
| *Paecilomyces fumosoroseus* | 7.2 ±4.0ab |
| *Beauveria bassiana* | 2.2 ±1.5ab |
| *Aspergillus parasiticus* | 2.2 ±1.5b |

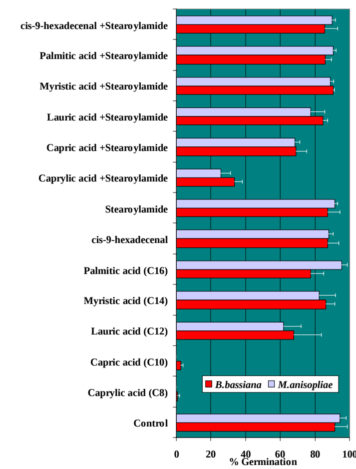


Figure 3. Effect of lipids on germination of entomogenous fungi. C16-18 fatty acids, C16-22 fatty amides and C15-17 aldehydes were detected on *L. bostrychophila*

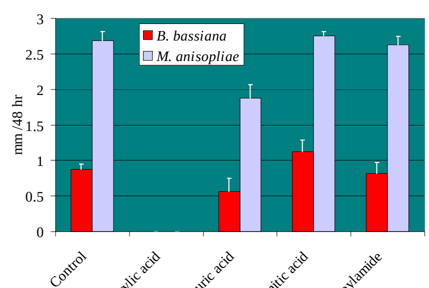


Figure 4. Effect of 2 mM lipid on radial growth of fungi on 25% Sabouraud daextrose agar.

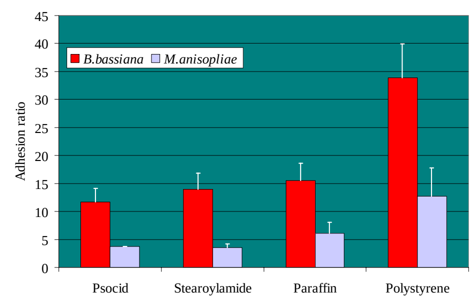


Figure 5. Conidia attachment to *L. bostrychophila* and lipid substrates, relative to glass.

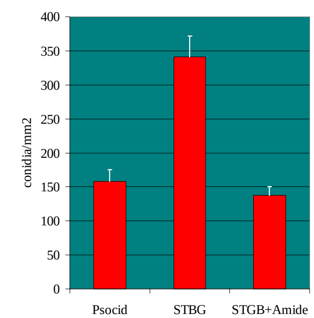


Figure 6. Adherence of *Beauveria bassiana* conidia to *Oryzaephilus surinamensis* (STGB) larvae with and without stearoylamide treatment compared with adherence to *L. bostrychophila.*